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Claims

1. An apparatus for carrying out fusion of biological cells, comprising:

5        an inner electrode having a first electrode radius (r1) and an electrode height,

         an outer electrode having a second electrode radius (r2) and said electrode height, wherein said inner electrode and said outer electrode are concentric,

10        a gap between said inner electrode and said outer electrode, wherein the size of said gap is the difference between said second electrode radius and said first electrode radius, and wherein a cell fusion volume is defined by said electrode height, said gap, said first  
15        electrode radius (r1), and said second electrode radius (r2), wherein said first electrode radius, said second electrode radius, and said gap are selected in accordance with a predetermined range of selectable ratios (r1/r2) of said first electrode radius to said second electrode  
20        radius, wherein said range of selectable ratios is from 0.7 to 0.9, a selected gap limited by said range of selectable ratios, and a determined ratio of said selectable ratios based on said selected gap, such that  
25        compression between the biological cells and permeability between cell membranes are maximized and temperature rise is minimized for providing cell fusion in said cell fusion volume.

2. The apparatus of claim 1 wherein said cell fusion  
30        volume has a volume of greater than 1 milliliter.

3. The apparatus of claim 1 wherein said ratio of said first electrode radius to said second electrode radius is in a range of 0.75 to 0.9.

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4. The apparatus of claim 1 wherein:

         said ratio of said first electrode radius to said

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second electrode radius is in a range of 0.8 to 0.85, and  
said gap is in a range of 2 to 10 millimeters.

5. The apparatus of claim wherein:

5       said ratio of said first electrode radius to said  
second electrode radius is 0.83, and  
      said gap is 4 millimeters.

6. A method for selecting an inner electrode, an outer  
10 electrode, and a gap between the inner electrode and the  
outer electrode for a cell fusion chamber for fusing  
biological cells, comprising the steps of:

      determining two of a first electrode radius of the  
inner electrode, a second electrode radius of the outer  
15 electrode, and the gap between the inner electrode and the  
outer electrode,

      setting the ratio ( $r_1/r_2$ ) of the first electrode  
radius to the second electrode radius to a value in a  
range between 0.7 to 0.9, and

20       calculating the third of the first electrode radius  
of the inner electrode, the second electrode radius of the  
outer electrode, and the gap between the inner electrode  
and the outer electrode, based on the set value of the  
ratio, such that compression between the biological cells  
25 and permeability between cell membranes are maximized and  
temperature rise is minimized for providing cell fusion in  
the cell fusion chamber.

7. The method of claim 6 wherein:

30       the ratio of the first electrode radius to the  
second electrode radius is set to a value in a range  
between 0.8 to 0.85, and

      the gap is in a range of 2 to 10 millimeters.

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8. An apparatus for carrying out fusion of biological  
cells, comprising:

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a non-conductive base member,

a conductive outer electrode supported on said base member, wherein said outer electrode includes a concave outer electrode surface which has an outer electrode  
5 radius ( $r_2$ ) and has an electrode height,

a conductive inner electrode supported on said base member, wherein said inner electrode includes a convex inner electrode surface which has an inner electrode radius ( $r_1$ ) and has the electrode height, wherein said  
10 outer electrode surface and said inner electrode surface are spaced apart from each other by a gap which defines a fusion chamber,

a non-conductive outer electrode cover member supported by said outer electrode, and

15 a non-conductive inner electrode cover member supported by said inner electrode, wherein said outer electrode cover member and said inner electrode cover member define an access channel, wherein said access channel is in communication with said fusion chamber.

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9. The apparatus of claim 8 wherein:

said non-conductive outer electrode cover member includes a concave outer cover member surface which has an outer cover member radius,

25 said non-conductive inner electrode cover member includes a convex inner cover member surface which has an inner cover member radius, and

said outer cover member radius is equal to said outer electrode radius, and said inner cover member radius is  
30 equal to said inner electrode radius, whereby said access channel is in registration with said fusion chamber.

10. An apparatus for carrying out fusion of biological cells, comprising:

35 a non-conductive support member,

a conductive outer electrode supported in a horizontal orientation by said support member, wherein

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said outer electrode includes a conductive concave outer electrode surface which has an outer electrode radius ( $r_2$ ) and has an electrode width,

5 a conductive inner electrode supported in a horizontal orientation by said support member above said outer electrode, wherein said inner electrode includes a conductive convex inner electrode surface which has an inner electrode radius ( $r_1$ ) and has said electrode width, and

10 non-conductive vertically oriented end walls located at ends of said outer electrode and said inner electrode, wherein said outer electrode surface and said inner electrode surface are spaced apart from each other by a gap, and wherein said gap and said vertically oriented end walls define a fusion chamber.

11. The apparatus of claim 10 wherein:

20 said outer electrode includes a non-conductive outer electrode support portion which supports said conductive outer electrode surface, and

said inner electrode includes a non-conductive inner electrode support portion which supports said conductive inner electrode surface.

25 12. The apparatus of claim 10 wherein said non-conductive support member, said non-conductive outer electrode support portion, said non-conductive inner electrode support portion, and said non-conductive vertically oriented end walls are formed as an integrated molded unit.

35 13. The apparatus of claim 10, further including an input/output port supported by said support member, wherein said input/output port is in communication with said fusion chamber.

14. The apparatus of claim 10, further including a filter

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pressure relief valve supported by said support member,  
wherein said filter pressure relief valve is in  
communication with said fusion chamber.